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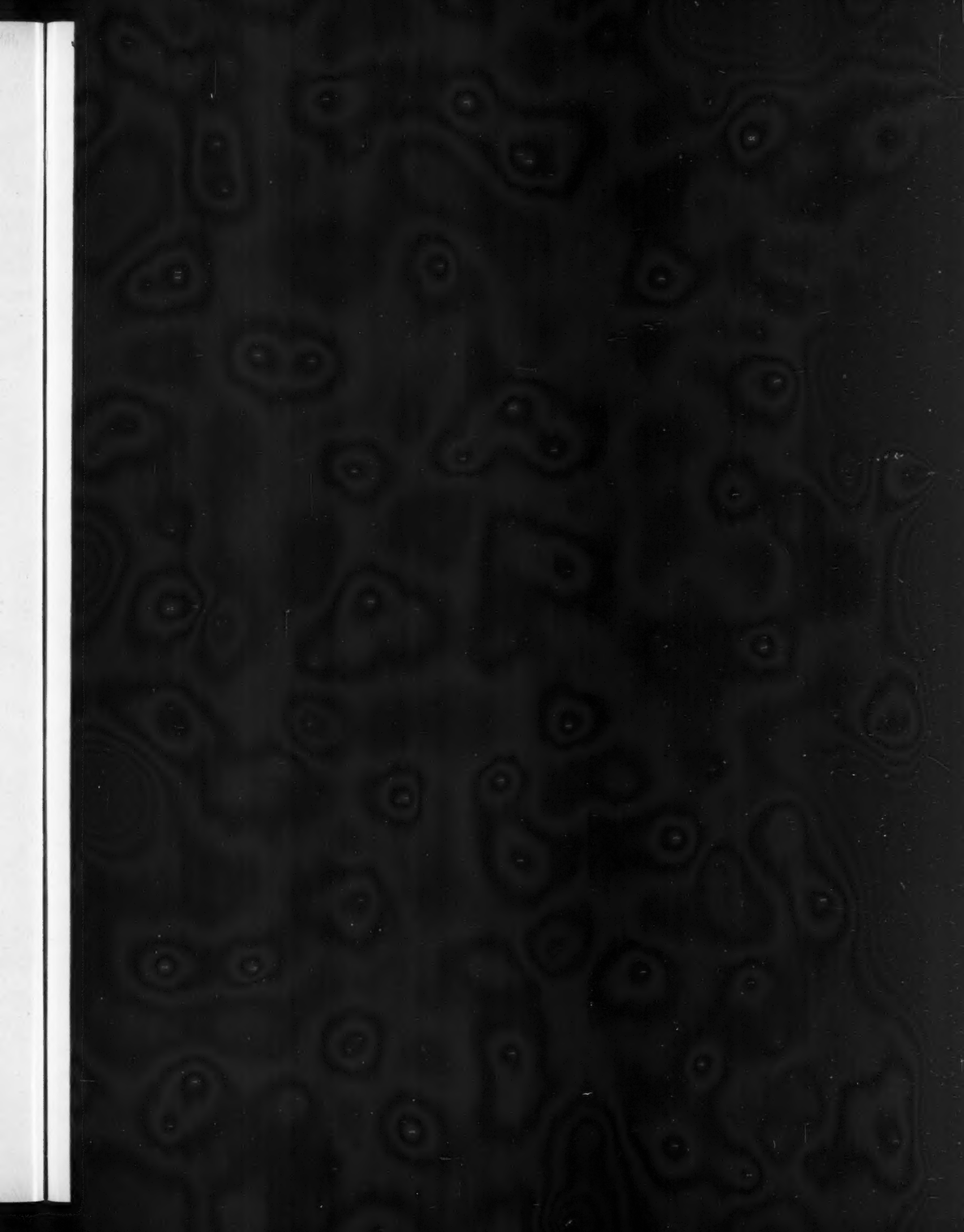

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SAN FRANCISCO'S ELECTRICAL FIRE PROTECTION

BY JOHN CARRELL

(Seldom has the means whereby a modern city is protected against fire been more interestingly described than in this article. It includes a description of the new central fire alarm station and gives all details of construction and operation. The author is electrical inspector with the San Francisco Department of Electricity.—The Editor.)

After San Francisco's great conflagration of 1906 had spent itself a crew of electrical workers salvaged the circuits in the unburned district and continued them to a temporary central station converted from an existing residence building. Later, when the reconstruction of the city assumed a definite course, a semi-permanent station of brick was erected somewhat closer to the central business district, near the site occupied by the present civic center. The first fire alarm lines installed in the newly builded section, although constructed of the best materials available at the time, were overhead lines of a temporary character.

San Francisco's Central Fire Alarm Station.

Early fire protection plans had included a permanent central station and an underground wiring system, but the execution thereof was delayed by scarcity of public funds and the fact that enormous traffic in building materials precluded the tearing up of the streets. In time, the financial aspect and other conditions became favorable and towards the close of 1915 the major part of the underground work had been finished, and the permanent central station, the final adjunct of an elaborate fire protection system, was completed and in service.

San Francisco is well protected from fire by (1) an adequate water supply system; (2) a trained and intelligent force of fire-fighters; (3) the most modern and effective portable fire-fighting equipment, and (4) a rapid, accurate and convenient method of transmitting both the intelligence which gives notice of the existence of a fire and the signals by which the fire department govern their movements during either normal or complex conditions. By these four dimensions the efficiency of a fire department is measured and

Typical Fire Alarm Box.

this paper will deal principally with the fourth dimension of San Francisco's fire department.

How the Department is Called.

Fire alarm boxes are placed at frequent intervals throughout the city, being mounted upon special standards or on street service poles and connected to the central station by means of an electric circuit.

The modern fire alarm box is of compact design. The door may be opened by breaking a small glass panel covering the latch. Just inside the door a small lever protrudes through the inner case upon which are the instructions "Pull down hook once and let go." The "hook" releases clock-like mechanism which rotates a character-wheel, or disk, having a series of uniform depressions in the rim; the depressions permit motion in a movable piece pressing against the rim, which motion opens and closes the circuit in a certain order so as to indicate a number. Also within the box, but accessible only to department employes, is a telegraph key and sounder.

Each box circuit is normally closed, i.e., current is flowing constantly, except during the breaks of a contactor, and the same circuit wire loops through the contactors of fifteen fire alarm boxes, average; thence both ends of the loop enter the central station and pass to the source of current supply through the necessary apparatus on the switchboard, chief among which are a telegraph key, or manual contacting device, and a relay, or small electro-magnet which operates the contacts of a second circuit simultaneously with the contacting at the fire alarm box. This separate or local circuit operates a telegraph sounder; starts a register, or contrivance which records dots and dashes on a paper ribbon passed under a magnetically operated pen; causes a lamp to flash the signal; and locks contacts which illuminate a transparent number list of the boxes on the circuit. These audible and visual devices are calculated to impress the eye and ear of the station operator with the box number at which the "hook" was "pulled." The character wheel repeats its message four times.

Other circuits extend from the central station to the individual stations, i.e., engine houses, valve stations, pumping plants, fire boats, etc., over which the make and break process is quickly repeated in the same sequence as indicated from the fire alarm box. To insure continuity these circuits are installed in duplicate, termed the "tapper" lines and "alarm" lines, and each set connects in series to an average of ten individual stations.

In the individual station a local circuit equipment, when contacted by a relay in the tapper line, causes the signal to be tapped on a large single stroke bell; operates a register; turns on the incandescent lights at night and where horse drawn vehicles are still used, magnetically releases the horses. The contacting of the alarm relay causes the signal to be confirmed on a smaller single stroke bell but operates no other device except the register.

The signal is repeated four times, twice on the tapper lines and twice on the alarm lines. The alarm lines are utilized independently to transmit signals which are essential to the operation of the fire department but which are not prime calls, i.e., which do not call units to a fire.

The firemen are literally off at the tap of the bell. The first alarm calls a certain number of the nearest companies. The senior officer of the answering detail may repair to the fire alarm box and by means of the telegraph key and sounder located within an inner compartment, call additional units to the fire or command the attendants of the high pressure water system and other auxiliaries through medium of the central station. Each chief is provided with one man whose principal duty is to remain at the fire alarm box and transmit orders sent from the scene of action.

All movements for each unit of the fire department, as well as for the auxiliaries, are pre-arranged and charted for every possible known condition. Each of the eighty companies is furnished with these charts in card index form and, in addition, a changeable chart or record-board, by which to record the units in and out of service and their positions. When a serious fire summons many companies from the surrounding districts, the companies still farther out systematically cover in to the vacated quarters of those in action in order to be more strategically situated in case of a general alarm or concurrent fire. Companies report "in service" on returning from a fire over a private telephone exchange; they also report out of service by the same means when accident or other condition

Half of Main Switchboard Room, showing Semi-Circular Board.

renders them temporarily unable to answer an alarm. The central station operators transmit all this necessary information to the fire department houses over the alarm circuits by means of a special code.

Auxiliary Alarm Circuits.

In order to work both ends to the middle it will be necessary to mention certain additional circuits. Firemen, like other public servants of high and low degree, must eat and leave quarters for the purpose, but are subject to recall; daily papers, some insurance institutions, etc., desire to receive all prime signals. It will be readily seen that a relay properly connected in circuit will transfer its signal to a second circuit, which second circuit may be relayed to a third and so ad infinitum. Each engine house has a relay circuit with separate primary battery, termed the "outside" local, which extends to the homes of firemen in the vicinity and to any other place where the installation costs and a nominal rental is paid.

There is a commercial firm which installs auxiliary fire alarm boxes in building wherever desired, from which points alarms may be turned in, thus saving the time necessary to travel to the street intersection. The auxiliary box circuit is provided with its own current source and is connected to a small auxiliary magnet in the municipal fire alarm box, which magnet, when properly energized releases the character wheel mechanism in the same manner as will pulling down the hook.

Still another commercial firm maintains auxiliary alarm posts in buildings, but carry the circuits into their own central stations, communicating the exact location of fires to the central fire alarm station by both telephone and telegraph.

A series of crossing signals warn street traffic when fire fighting units must cross the main thoroughfare of the city at high speed. These signals consist of large gongs and red lights mounted on special standards. A circuit from the central station operates a remote control switch in a down town engine house and closes a 220 volt multiple circuit to which the crossing signals are connected.

Central Fire Alarm Station.

The new permanent central fire alarm station is in Jefferson square, a public park of the residential section near the center of property valuation, and is immune from liability of fire due to external causes, the nearest buildings being more than 300 ft. away.

The building is of an artistic design, compatible with its beautiful surroundings; is one-story in height with a basement and has a total floor space of 8500 sq. ft., nearly; was designed for and is used exclusively to house the central station apparatus; is of steel frame, reinforced concrete construction, and, as no wood is used even for floors, doors or windows, instrument cases or the like, there is no liability of fire due to internal causes. To be absolutely certain on the latter point a liberal supply of hand fire extinguishers are distributed about the building. The upper story is occupied by the main switchboard room, the private telephone exchange and several small rooms for convenience of the operators; the basement by a battery room, emergency power plant, cable rack and a dormitory with dressing room, shower bath, etc., for use by the night line trouble detail.

The switchboard room is 48 by 64 ft. in horizontal dimensions and 16 ft. ceiling height, with walls and ceilings plastered and ornamented with coves and mouldings. The floor is covered with heavy linoleum. An even light is diffused throughout the room by means of clear glass skylights set above a plane of maze pattern wire glass which forms a large part of the ceiling. Artificial light is furnished from semi-direct bowl type fixtures and by an emergency set of lamps equipped with reflectors of clear prismatic glass and placed as a border around the glass portion of the ceiling. Heat is furnished by a hot water circulating system and fresh air distributed by means of wall vents and ceiling openings.

The switchboard is of marble; is 8 ft. in height, and is arranged in a semi-circle of 29 ft. radius. Its form includes an offset to provide a bench 18 in. deep and 3 ft. high, upon which to mount apparatus adapted to a horizontal surface. The base of the board is of verdi antique marble from which rises the face of the bench in white statuary marble; the horizontal slab and vertical panels are of blue Vermont and above the vertical panels runs a moulding of beautiful Sienna. The two terminals of the semi-circle abut the front wall of the room, between which terminals the wall is treated with a similar arrangement of marble in harmony with the board, forming an enclosure which will satisfy the most critical eye. In the center

of the room is an elegantly carved marble desk equipped with apparatus for master selection and control of all prime circuits and essential auxiliaries.

In the space back of the switchboard are several additional bench boards and vertical panels on which are mounted diminutive dynamotors, motor-generators and battery charging control apparatus. One panel is devoted to switches controlling commercial light and power circuits which enter the building. Doors are inserted in the main switchboard at intervals.

The switchboard is equipped with apparatus for 45 signal circuits, 8 tapper and 8 alarm circuits, separately grouped. A fourth group of circuit apparatus, termed the "hospital," is arranged for the nursing and special treatment of circuits subject to electrical troubles.

All circuits enter the building through lead covered cables which pass from a pit in the center of the basement to a cross-connecting terminal rack directly above. Thence the circuits connect to station cables and pass over a metal runway suspended from the basement ceiling to the several panels where each circuit connects to the center contacts of a vertically mounted two-blade, double throw knife switch. This switch, when thrown up, connects the circuit to its respective apparatus on the board, but when thrown down transfers it to the hospital. After leaving the upper contacts of the double throw switches, all circuits in common pass through ½ amp. 2500 volt fuses and vacuum tube arresters to the contacts of a ground test switch by which either side of the line may be connected through a volt meter to the ground; but from thence the apparatus differs for the box signal circuits and for the tapper and alarm class of circuits.

In fire alarm and similar work the right side of the circuit, as you face the panel, is termed the E (east) side of the line; the other the W (west) side.

The box signal circuits, after leaving the devices mentioned as common to all circuits: the W side passes through a milliammeter; thence through the coils of a 150 ohm relay; thence through a switch by which to throw in or out of circuit a resistance equal to that of a fire alarm box telegraph sounder; thence to the central control desk, through a closed circuit receptacle, or jack, and back to the panel, thence through a closed circuit telegraph key, and to one center contact of a two-blade, double-throw knife switch, which connects to the normal current source or to a spare source. The E side passes through a duplicate relay; thence through a current adjusting rheostat and through a duplicate telegraph key to the other center contact of the current supply switch. On the panel the two relays are mounted in the same frame and the keys parallel. The equipment of four such circuits, with appurtenant devices, comprise a switchboard panel.

The normal current supply for the box signal circuits is a 60 watt, 70 volt dynamoter, or machine in which the armature of a generator and motor revolve in the same field, one machine for every panel. The spare source is a battery common to all circuits and is used for individual test. Current on each signal circuit is maintained at about 100 milli-amperes.

The function of the relays and the audible and visual devices they cause to operate have been previously mentioned; but the local circuit which energizes these appurtenant devices is from a separate 16 volt source and is not connected to the main line equipment except at the secondary contacts of the relays. The secondary apparatus includes a small two-throw lever switch by which the audible devices may be silenced, either singly or for the entire board; also a set of push buttons will turn out the lamps behind the transparent box number lists.

The tapper circuits are more diversified than the box signal circuits, which is fortunate as the current of human interest suffers quite a drop in potential after passing consecutively through the varied devices which comprise a complete cycle of duty.

Apparatus of four tapper circuits constitute a tapper panel and includes an eight-pole double-throw relay having two sets of stationary contacts and a movable set. The coils which operate this relay are connected in series with a master telegraph key on the central desk. Each tapper circuit, after leaving the devices common to all circuits, pass through a resistance balancing rheostat on the W side and a 20 ohm relay on the E side, thence both sides terminate on two of the movable contacts of the striking relay. When a signal is being struck out the movable contacts are successively pressed against the upper stationary ones and send out pulsations from a 220 volt current source which is sufficient to operate the engine house relays and notifies the fire fighters on watch; but, when at rest, the striking relay connects each circuit through a highly sensitive 500 ohm relay, a milli-ammeter and knife switch to a supply source adjusted at 20 milli-amperes, a current too feeble to affect the individual station relays but ample to hold up the armature of the sensitive 500 ohm relay, thus maintaining a constant test for accidental breaks in the circuit wire. The upper contacts of the striking relay are alive only during the signaling period and the feeble current is disconnected during that time. This switching operation is performed by remote control switches elsewhere on the board but also manipulated from the central desk. A separate 60 watt, 30 volt motor-generator supplies closed test current to each panel. Also there is a spare source for individual test. The local circuit for the tapper panel operates a register when contacted by the 20 ohm relay and causes a lamp to glow behind a transparent number list of individual stations when contacted by the 500 ohm relay.

The alarm circuit panels and striking equipment are separate from the tapper panels but are exact duplicates thereof.

The current which supplies both tapper and alarm equipment with 220 volt striking current is carried to the control desk where it may be connected either to a commercial source or to an emergency 1 kw. motor driven generator, operated either from a commercial source or a 120 volt storage battery.

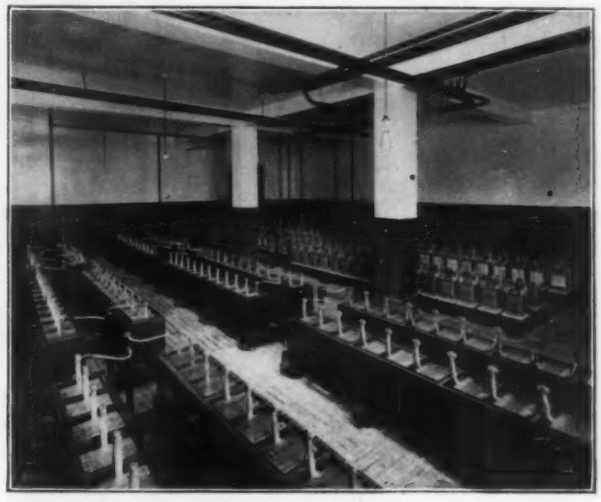
There are two operators on duty at all times, termed the relay operator, who takes care of incoming business, and the key operator who handles all outgoing calls. The post of the key operator is the central control desk where he is the master of all he sur-

veys or the servant, as the case may be. By inserting a plug in the proper jack he can cut in a telegraph equipment on any signal circuit. His local circuit equipment provides control of sounders, number lists, etc., and includes a master register for each class of circuits. He can also be connected by telephone to all the individual stations over a private exchange.

Hospital Panels.

When a circuit is out of working condition it is transferred to the hospital. The transfer circuit terminates in a receptacle on a panel devoted to jacks. The hospital circuit terminates in a plug in front of the jack panel. Hospital panels are similar to the other panels for the respective classes of circuits but

Generator Room.



Battery Room.

are supplemented with apparatus by which troubled circuits may be isolated, tested, provided with an individual current source and nursed until normal conditions are restored. When a plug is raised from its position on the bench the motion permits a switch to close which starts an individual motor-generator set to supply current to the troubled line, and when the plug is properly inserted, the hospital is working. Tapper and alarm hospital circuits are each provided with two small motor-generator sets, one for closed test and one which supplies 220 volt striking current.

The most common of troubles are open circuits, grounds, and occasionally the presence of foreign currents. Circuits afflicted with grounds or foreign current troubles may be usually kept working when supplied from a separate current source. An open box signal circuit is a serious matter and when this occurs the operators connect one pole of the current source to the ground and the other pole to both sides of the circuit and then request department employes to close in along the circuit route to signal through the ground from certain boxes. A ground switch is closed in the two boxes adjacent to the break, thus bridging the circuit until the repair detail can correct the trouble.

In case of an open tapper or alarm circuit the operators by telephone direct the manipulation of switches in the individual stations to discover and to bridge the break through the ground, pending repairs.

Current Supply.

A constant electric power supply to operate the central station is a vital item. Service circuit from four different commercial sources enter the station, two of which are direct current and two alternating; but to provide against failure of all these, the station is equipped with a 7½ kw., 120 volt, d.c. generator. There are also two 120 volt storage batteries each of 280 ampere hour capacity.

All motor-generators and dynamotors which supply current to the main line circuits are normally driven by 120 volts direct current from either commercial source. A storage battery is connected to this circuit but does no work except during failure of the source; i.e., when the supply source drops below a minimum pressure it is disconnected by an automatic switching arrangement and the battery carries the station. One storage battery is held in reserve.

Storage battery charging may be effected from a commercial source, in which case 220 volts are applied through a current limiting device or from a d.c. generator driven from either of two motors. One motor causes alternating current power to be translated into direct; the other may be operated from any direct current source, this later arrangement tending to secure a steady current from a less stable one. Push button control from the operating room is provided to operate the generator.

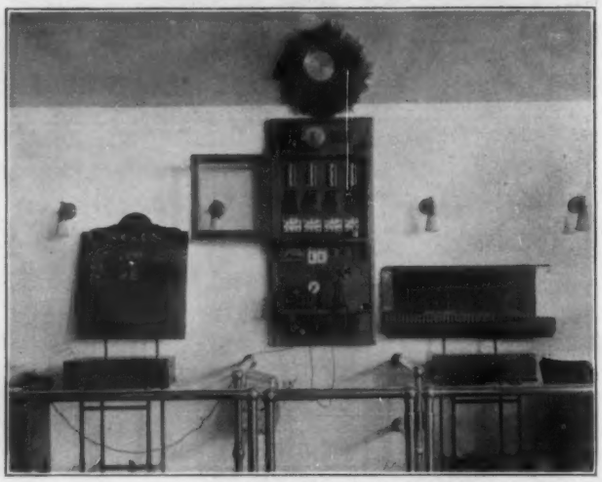
The 16 volt current for local circuits is secured from taps to the 280 ampere hour batteries.

As a precaution against possible explosion from the gasoline engine equipment and the gas appurtenances of the hot-water heating system, these appliances, with the larger motor-generator sets, are placed in a basement room separated from the rest of the building by heavy concrete partitions.

Character plays an important part in fire alarm work: to have absolutely automatic character wheel mechanism by which the citizen or non-expert may call the department and to have the system in charge of expert men of known judgment and ability. From this point of view the San Francisco system was designed.

Many central fire alarm stations are provided with automatic or semi-automatic means by which to transmit calls to the engine houses. The San Francisco system is manually operated, the designers believing the automatic method the slower one and that where automatic operation does not save time it is inferior to manual operation by experts. However, provision has been made for the future addition of an automatic transmitter if desired.

The fire alarm boxes in general use are plain boxes, so called in contradiction to certain patented and elaborated types. All vicinity boxes are connected to different circuits, i.e., the circuits are interlaced. This feature is designed for multiplicate protection and to prevent two boxes of the same circuit from being pulled simultaneously by persons starting in opposite directions from the same fire.



Typical Station House Equipment.

A machine shop, equipped to manufacture and repair signalling apparatus, and a small garage are maintained by the department in charge of the fire alarm system, but are housed in a separate brick building several blocks from the central station. The shop manufactured most of the switchboard apparatus for the new station and is now constructing new fire alarm standards for use with the underground cable system. This standard is of beautiful design executed in cast metal and comprises a fire alarm box head-piece mounted on a square post, or casing. One distinctive feature is the position of the small glass panel directly over the hook, this simplifying the procedure of turning in an alarm. The hollow post is provided with a door and is designed to hold battery for auxiliary box circuits.

The installation of electrical equipment of the new central fire alarm station, a project which required correlations of the work of many men, was made by James M. Barry, chief department of electricity; Paul J. Ost, chief electrical assistant to City Engineer M. M. O'Shaughnessy, was in charge of electrical design. A. Lacy Worswick, chief draughtsman board of architecture, designed the building. R. W. Wiley, superintended the electrical construction and to him must be given credit for many of the refinements of operation embraced by the new installation. Frank Ichoff, shop foreman, department of electricity, supervised the construction of switchboard apparatus.

DIESEL ENGINE PRACTICE.

BY J. E. MEGSON AND H. S. JONES.

Life of the Diesel.

The life of a Diesel engine is something that is often discussed. It is not unusual to find steam engines and steam pumps which have been in service thirty years, maintained in fair state of up-keep by repairs and renewals. The frame, shaft, flywheel and foundation, representing a large part of their original cost, continue in service. Yet, the engine and pumps represent less than forty per cent of the cost of a steam installation—about sixty per cent being in the boilers, heaters, condensers, stack and piping. Some of these features, the boilers notably, each year show a marked deterioriation and loss in efficiency. None of these features exist in the Diesel, and its life will compare most favorably with the entire equipment of a steam plant, its efficiency throughout its life remaining practically unimpaired.

The story of the Diesel engine is quite different from that of gradual obsolescence of the old steam plant. Ten, even fifteen years ago, when the Diesel was first built, it showed the same extraordinary efficiency. No builder of Diesels abroad, nor do we here, expect to increase its thermal efficiency to a very great extent. Diesel progress has been one of increasing refinements, a lengthening of its life, an increasing of its reliability ad facility in handling and a perfection of its governing under varying loads. In these it is unapproached by any other type of prime mover.

The heavily designed frame, the shaft, and connecting rods, the massive fly wheel, etc., form a much larger proportionate cost of Diesel equipment than do these parts in a steam installation. Since these non-wearing parts form the larger cost, those parts which wear and deteriorate most, of necessity, form a less proportionate part of Diesel equipment than they do of steam equipment. It is easy to realize this by recalling that the entire boiler equipment, with all its auxiliaries, is eliminated, and that wear and tear is confined to parts which represent less than one-third of the original Diesel investment.

In the steam engine and in all explosive and hot-bulb types of internal combustion engines, leaky valves and worn cylinders result in reduced efficiency, the cause of which is not always apparent. If the engine is not loaded to capacity this consequently may not be detected until much damage has been done and much money lost. The Diesel, depending upon perfect compression for its ignition, does not permit a continuance of such losses; if compression fails ignition ceases and the engine stops. In other words such conditions as militate against the life of engines and their economy absolutely cannot exist long enough in the Diesel to do serious damage, or consume fuel in useless effort.

Another feature of the Diesel which adds to its life, and which sets the Diesel apart from all explosive types, is the absence of any sudden rise in pressure at instant of combustion. Gradual introduction of fuel during ten per cent to twelve per cent of the combustion stroke results in a more uniform stress and longer life.

Two 225 h.p. Diesel engines in a Texas power

house during the nine years since they were installed, have operated on an average eighteen hours per day. Their cylinders were rebored after nine years' service. With the same handling in the future as they have had in the past, they should outlive a steam plant of like capacity.

With late designs, the wear and tear on the operating parts will be much less than in the older design. In the first engines, the cylinders were solid, so that in five or six years, as they became worn, it was necessary to bore them out and purchase new pistons. In the later designs the cylinders are fitted with a liner so that they may be replaced by merely lifting them out and slipping new ones in their place. These liners are made of cast iron and require only a small amount of machine work, so naturally are not expensive—simply a case of cast iron at so much a pound. With this system, new pistons are not required, as the piston of a Diesel engine never wears, simply the rings and the cylinder walls.

Reliability.

The reliability of the Diesel engine has been doubted for many years, not from the performance of the engine itself but from false reports. However, judging from the experience of the numerous plants that have been in continuous operation, they have proven very successful.

The water pumping station at Sherman, Texas, owned by the city, is a fair example. This is an installation of two 170 h.p. engines which for the past four years have been operating continuously 24 hours a day on 30 day runs. At the end of this time the engines are shut down, inspected and adjustments made if they are required.

There are any number of plants that have but one engine used for city lighting service and in manufacturing industries. If the engines in either case are operated on 24 hour schedule they arrange to shut down for a few hours on Sunday for inspection.

The City of Donaldsonville, Louisiana, purchased two 170 h.p. Diesels in about 1912. These engines furnished the light and the power for the city water works system. While a great many cities in the south have a standpipe in connection with their water service, Donaldsonville pumps directly into their lines, the pumps being driven with motors operated automatically to hold 50 lb. pressure on the system. The reliability of the Diesel engines in this plant was highly endorsed by the Fire Underwriters and the plant shows a wonderful saving over their old steam plant. The steam plant used 32 barrels of oil in 24 hours or 90 barrels of coal, while the Diesel plant, with practically the same load, uses 3½ barrels of oil per 24 hours, a saving of between $1000 and $1100 a month in fuel for the city.

The Texas & Pacific Railroad Company operate two of their railroad shops with Diesel engines, one at Marshall, Texas, the other at Big Springs, Texas. The Marshall engine has been operating a number of years, and judging from reports received from their mechanical engineer, this engine is giving perfect satisfaction, not only in the extreme economy of operation, but wonderful economy in upkeep. They state that their engine consumes 8 gallons of fuel per hour with an output of 90 kw., also that the average upkeep of the engine for the past three years has not been more than $2 a month—their engineer knows his business! The engine in the shops at Big Springs has been operating over two years with perfect success and little upkeep.

Another marvelous example of the reliability of the Diesel engine, both for endurance and upkeep, is at Plant City, Florida. This engine furnishes the lights for the city, in connection with furnishing power for manufacturing ice. The engine is 120 h.p. and was operated almost continuously for three years before any repairs were made. When the engine was overhauled the writer was there to note its condition and found out of eighteen rings, only two piston rings broken on the three pistons. None were stuck, and the cylinders were in perfect condition, as smooth as a looking glass. When the reliability for continuous operation is questioned it is safe to state that the Diesel engine is fully as dependable, if not more so, than the steam plant, when upkeep of boilers, pumps and auxiliaries is considered.

The City of Lyndon, Kansas, was operating a modern steam engine, in excellent condition, in fact when it was sold second hand it brought nearly full price. While operating the steam engine they only ran from dusk to dawn. Their average oil consumption was 1 bbl. of oil per hour; if they ran 10 hours it was 10 bbl.; if 13 hours 13 bbl., etc. The city installed a 120 h.p. Diesel engine three years ago, turned around the generator which had been belted to the steam engine and belted it to the Diesel. The load has been increased by extra street lamps and new residence users and storekeepers, but even with the increase of output the Diesel engine does not average a barrel of oil per night, figuring 365 days a year. Naturally they are highly pleased and are now considering the purchase of another Diesel and furnishing lights and power for small surrounding towns.

The longest run the writer can recall was 94 days continuous operation in Jerome, Arizona. The plant consisted of two 225 h.p. Diesel engines connected to a Root blower with rope drive, ventilating a mine. This we consider "going some" for combustion engines, and they were operated on California fuel oil containing 25 per cent asphalt.

Another Diesel plant at Coeymans, N. Y., furnishes the light and power for three towns, namely, Coeymans, Ravina and New Baltimore. It has been in operation for the past seven years and the owner stated on several occasions, when asked what he thought of Diesel engines, that if he had his choice of being presented with the best reciprocating steam plant that could be furnished, and he had to buy the fuel to run it, he would much rather pay the price for Diesel engines. This plant, without a doubt, is the cleanest and best kept Diesel plant in the United States. The first two engines installed were 120 h.p. Since that time they have purchased two more, one 120 h.p. and one 225 h.p., all direct connected to a.c. generators operating in parallel. These are simply instances of typical Diesel plants of which there are now over 400 in operation in this country.

THE SNOW-FLAKE IN INDUSTRY.

BY BENJAMIN F. PEARSON.

(This suggestive bit of poetic prose tells in a fitting manner of hydroelectric power's contribution to civilization. It was read before the Jovian Electric League of Southern California on Dec. 29, 1915, by the author, who is general superintendent of the Southern California Edison Co.—The Editor.)

In a recent poem, written by Mr. Charles Heston Pierson, snow was referred to as "The New White Coal," and I can not do better than preface my few remarks by reading it:

"Oh, peaks of the grand Sierras, that lift your heads so high
That the drifting snow of the winter clings 'neath a summer sky;
Oh, peaks of the High Sierras, where the fleecy cloud banks roll,
Do you know that the snow which you cherish is known as 'the new white coal?"

Do you know that when it leaves you, trickling away in the sun,
That it goes on a mighty mission, and its task is just begun?
Do you know that when it leaves you, to course down your rugged sides
Forming the stream and the brooklet and the river's roaring tides,
That its rush is the power of the turbine, that generates the spark,
Which is carried away and away on the wire, dispelling the night and the dark;

That it drives the busy factory where once the chimney loomed;
And quiets the noisy engine that puffed and fretted and fumed;
That it cooks in the cottage kitchen; and warms where the family meet;
And does those things which coal did do when it was our light and heat?
Oh, peaks of the High Sierras, where the cloud banks softly roll,
Cherish the snow on your icy crests that is known as 'the new white coal.'"

The snow-flake, emblem of eternity, chastity, charity and better yet, an emblem of energy; it is the hand-maiden of industry; a spoke in the wheel of progress. Man is rapidly subduing and subjecting to his control, the forces of nature, and man today owes it to the man of a thousand years hence to contribute to the conservation of the natural sources of energy, and notwithstanding the future may demonstrate the successful harnessing of solar energy, and the limitless power of the tides, the problem of greatest moment are those in our immediate fore-ground. When one hundred years have rolled around and Mother Earth shall have disgorged her last ton of coal, and the last gallon of oil has been wrested from her embrace; when all the waterfalls and the current of the river shall do man's bidding in perpetual service, then may man look to the hills, "from whence cometh our strength," and thank this generation that in our wisdom we stayed the hand of the ruthless slayer of forest and woodland, halting devastation and deluge; in its place making the timber line sacred and the halting place for commerce, so that the snows of future centuries might find a resting place among the mighty pines, and only yield itself gently to the allurements of the summer sun, instead of plunging wildly down the mountain slopes, hand in hand with destruction. Then will there be added meaning to

"I love thy rocks and rills,
Thy woods and templed hills";

And the electrical industry is deeply interested, with every good citizen in the conservation of Nature's forces. Industry is demanding more and more of our natural resources. Last year approximately 600,000,000 tons of coal were mined and consumed, and petroleum oil equal to about 27,000,000 tons. Nature gives us one hundred per cent, and notwithstanding the almost magical strides in electrical and mechanical engineering, less than three per cent of the fuel consumed finds its way to the incandescent lamp in the form of light.

We place a ton of fuel in the furnace and we deem ourselves fortunate to extract from it, through the medium of boiler, engine and dynamo, fifteen per cent; on the other hand, we drop one ton of melted snow on a water wheel and extract from it eighty per cent. At the present time the melting snows of a thousand hills are contributing to the delivery in centers of industry of 6,500,000 h.p., and waiting patiently the touch of the engineer, banker and artisan 45,000,000 h.p. is going to waste, equalling approximately 7,000,000,000 gallons of oil annually, or equal to the average total world's production of oil for thirty years.

The history of the evolution of industry is the history of the achievement of individuals, and while it is true that we have to give credit to the builder of 5000 years ago, for the greatest known monuments in architecture, and our standards in art date back 2000 years, yet the achievements of science only date back to yesterday.

Possessing all of the natural resources necessary in the development of every industry, it only remained for Yankee ingenuity to develop and build and master every art and science necessary to the progress and spirit of the age, until today America is recognized as the richest and greatest nation in the world, as well as the leader in industrial development.

The history of the past one hundred years reads like a fairy story, and forms a new Arabian Nights. Jefferson said it would be one thousand years before the Great Northwest could by any possibility be settled. He could not foresee the wonderful inventions that have united the North and South, East and West. The wildest visionary of fifty years ago would not have dared to prophesy those things which have become, not simply luxuries of modern life, but the actual necessities in the transaction of every-day business, and the greatest factor of all is the generation and transmission and use of electrical energy. If by some cataclysm of Nature, or some reversal of Nature's laws it were not possible for man to harness the magnetism of the poles, the world would immediately come to stand-still; the mighty ships of the sea, including all her navies and the subtle submarine, and transportation in almost every form, including no fewer than two million automobiles in use in the United States alone, would suddenly halt; aviation would cease; and the whole world woud face ruin, and would have to begin again to solve the problems of existence, where we started fifty years ago. The smelter and the foundry, the machine shop, the textile factories; in fact every industry and avenue of trade would be paralyzed, and it is doubtful if the ingenuity of man could find any possible substitute.

If I were an artist, I would create a figure, representing electricity, standing with one foot on the North, and the other on the South Pole, reaching out

with one hand into space, taking hold of the powers of omnipotence, and with the other, reaching down and lifting humanities' burdens, and making possible the dream of the alchemist.

To the mind not trained in terms of electricity, and even to those whose minds are trained, the developments of even yesterday fill with wonder. When DeForest, in his investigations and experiments in the development of wireless telegraphy discovered what is now known as the Audion, making possible the transmission of sound over telephone wires between the Atlantic and Pacific states and making possible the transmission of sound without the medium of wire or conductor other than the atmosphere, it would seem as though he had performed the last act, linking humanity with infinity. As we hesitate a moment, and picture to ourselves the head of the United States Government, sitting in his chair in the City of Washington, talking into the telephone, speaking directly to the heads of government of every nation, kindred and tribe of the earth at the same time, it seems almost impossible, and beyond the ken of things we understand, yet the little instrument that makes this possible is not much larger than a full-grown incandescent lamp; in fact looks very much like one; so that notwithstanding the first transatlantic Marconigram was published in the Los Angeles Times March 30, 1908, the wonder of wonders now bows the knee and worships at the shrine of Wireless Telephony!

Step has followed step in such rapid succession in invention and in the industrial arts, that it is impossible, even with the most meager birds-eye view, to grasp what it all means. Within the memory of men living we have passed from the tread-mill to the modern dynamo, from the old spinning wheel to the modern loom, from the old hand press to the modern Hoe printing press, producing with more than human precision, 75,000 sixteen-page, multi-colored newspapers per hour, printed, folded and ready to mail; consuming a total length of 300 miles of paper.

It seems almost like a flight of the imagination when we consider the step from the prairie schooner of '49 to the modern monoplane capable of a speed of 140 miles per hour. It would consume hours to touch on the various distinguishing features in the progress of our age. It seems but a step back to the day of the old pine knot torch of our fathers, until now we accept without question, and without any investigation, the science that makes it possible for you or I to turn a switch and throw a beam of light no less than seven miles, sufficiently strong to enable our neighbor at that distance to read his evening paper!

In the United States alone the interests of public utility companies, engaged in selling electricity, total the sum of $2,800,000,000; and in the telegraph and telephone business there is a total investment of $2,094,000,000, requiring for the transmission of messages no less than 38,000,000 miles of wire.

It has been truly stated that the industry is young, and it is only a day or so since a few hardy pioneers of Southern California gathered in the little town of Redlands, and looking at the snow-capped mountains, wondered why it would not be possible to improve on the old water wheel of the mill, and generate electricity. After patient investigation, backed by the determination to win, the snows of Mount San Bernardino, Greyback, and the range adjacent to them, were made to contribute their potential power to the necessities of the communities of Redlands, Riverside and Colton, and the first three-phase hydroelectric station was placed in operation in the year 1893, and in 1898 the most daring feat in electrical engineering was performed, when this same group of pioneers backed by the counsel, capital and co-operation of Mr. John B. Miller, president of the Southern California Edison Company, harnessed the streams of Bear Creek and Santa Ana, daring to presume to transmit power to the City of Los Angeles over wires, a distance of seventy-five miles; and it is interesting to note that many of the leading engineers in the electric industry, today, who were then young and who have since become great, prophesied failure. The fact, however, was accomplished, and Los Angeles was electrically connected to the drifting snow of Greyback.

During the nineteen years that have intervened this projest has lost its place as one of the wonders of the engineering world, and we now wrest power from the snow-capped peaks of mountains two hundred and fifty miles away! Is it any wonder then that we have given some consideration to the "snow-flake" as a tremendous factor in industry, possessing as it does, aided by the skill of man, potential power which is eternal; not one flake but does not, at some time, reach the sea, and not one flake but that sooner or later is sent back on its mission, and again finds a resting place on some mountain peak, waiting its bidding, to pass on and carry with it life and health and power.

And what of the men who have made all these things possible, men who have devoted and consecrated their lives to scientific research, that you and I and our millions of brothers, and the generations that shall follow, might have all of the privileges of modern science ready to do our bidding at a moment's notice.

As we scan the horizon we see the towering figures of Edison, Graham Bell, DeForest, Tesla, Marconi, Sprague, and many others, who fought, not as seeing the reward, but in an unselfish endeavor to wrest from Nature some of her secrets and scatter the harvest broadcast. We reverently pay them homage, and it is not lightly that we refer to the words of that immortal American, Abraham Lincoln, when standing on the field of Gettysburg, he gave utterance to that wonderful eulogy, and said "We came here to dedicate a portion of that field as a final resting place for those who gave their lives, that this nation might live, but we cannot dedicate, we cannot consecrate, we cannot hallow this ground. The brave men, living and dead, who struggled here, have consecrated it, far above our poor power to add or detract."

The British thermal unit (B.t.u.) of heat energy is equivalent to 777.5 foot pounds of mechanical energy. It has also been largely adopted as 1/180 of the heat necessary to raise one pound of water from 32 to 212 degrees.

REPORT ON THE COLUMBIA RIVER POWER PROJECT.

Appendix E—Available Power.

BY L. F. HARZA.

The program of head control illustrated in Fig. 20, which was discussed in Appendix D chiefly from the standpoint of property damage from the backwater, first needs additional discussion with reference to the practicability of station operation under this program.

Turbine efficiencies and erosion. For best efficiency the speed of rotation of a turbine should change with every change in operating head. This is impossible when attached to an electrical generator without causing a change in frequency, and the speed must therefore be kept constant. The speed of a generating unit must be chosen for best efficiency at the normal head or the head under which it is to operate for the largest number of days per annum, the efficiency then falling off for both larger and smaller heads.

During the last ten years the science of hydraulic turbine design in the United States has undergone an unprecedented development, especially along the line of increase in speed, maximum efficiency and in efficient operation with wide range of variations in both gate openings and head. Several turbines have now been tested at Holyoke which have shown efficiencies of about 90 per cent or better. In at least one instance for the very high specific speed of 90, at which efficiency is much more difficult to obtain, an efficiency of 88 was secured; in another instance an efficiency of 91.5 per cent was secured at a specific speed of 64.0.

It has also been demonstrated that the Holyoke test offers, if not a satisfactory basis for closely predicting actual turbine efficiencies after installation, yet at least, a very satisfactory basis for comparison of relative efficiencies after installation. Tests after installation have also been assuring as to the practicability of safely using the Holyoke test of a small runner as a basis for the design of a much larger runner for operation under a much higher head such as would need to be done for this project. In fact, the efficiency in service has nearly always exceeded the efficiency of the small model runner at Holyoke.

Without going into detail regarding the test data it may be said that an analysis of the tests of several of the best runners submitted by several turbine builders has shown that reasonably efficient operation through a range of heads from 105 ft. down to 45 ft. is entirely practicable hydraulically and that turbine efficiencies can be realized of about 74 per cent at 45 ft. head, 86 per cent at 70 ft. head and 77 per cent at 105 ft. head, based upon a selection of speed for best efficiency at 70 ft. head and after subtracting about 3 per cent from the Holyoke test to allow for frequent operation at other than the best gate opening to serve a variable load and to affect the distribution of the load among the units. These efficiencies are not based upon the best of the tests submitted but are fairly representative.

The regular operation of the units through this wide range of heads is subject to two objections: The lowest efficiencies are obtained at the extremes in head and result in a sacrifice of station capacity at low water when efficiency is of greatest value; and necessitate a larger canal, as well as more machinery and power house space, during low or flood heads.

The buckets of turbine runners are subject at times to a severe erosion or pitting which appears to increase with the amount that the runner is operated at other than normal head, or the head for which its speed is best adapted, especially higher heads. It also increases with the amount of operation at low gate opening. Its severity is further dependent upon the material of which the runner is constructed and upon the correctness of the design of the runner by which smooth flow of the water in parallel filaments and without violent agitation is secured.

The cause of this action has never been fully explained, or at least not generally agreed upon. The opinion may be ventured that violent agitation is the dominant cause and that the other causes above mentioned are effective chiefly insofar as they cause this agitation. The condition is believed to be in every way comparable with that discussed in the chapter on geology in explanation of the formation of the deep pool below the damsite. Any violent agitation of water passing over a surface, whether caused by a depression already existing in the surface, by a too rapid expansion, by the impact of the water against the buckets in entering, or other imperfection of the flow channel, causes the suspended particles of sediment in the water to be thrown violently against the surface in a truly sandblast manner, causing rapid erosion where smooth flow of water, even if full of sediment, would have comparatively little effect. In fact it is not unreasonable to expect that a violent action of this sort even with pure water might set up destructive molecular activity sufficient to cause this erosion. Based upon this theory and as shown by actual service, high efficiency in a turbine is believed to be, to a considerable extent, an insurance against severe action of this sort.

Choice of turbines. To minimize the danger of runner erosion and to obtain higher efficiencies at the extremes of head a scheme has been worked out by which two types of units would be used, one set to operate through a low range of heads, from minimum to about 85 ft. with best speed chosen for about 63 ft., and the other to operate chiefly through the upper range with best speed chosen for about 85 ft.

For the maintenance of the continuous or perennial power of the stream during a normal year, the high head units would not need to operate below a head of 70 ft. During the rare occasions, however, when the flow would exceed 700,000 second feet and the head drop below 50 ft. the high head turbines would again be brought into service. They would operate at an efficiency, at 45 ft. head, of only about 62 per cent, but their use would avoid the installation of additional low head units for these extremes. The length of time during which they would thus be operated at this low head would be too short and the occasions too rare to make the question of runner erosion of any importance. Using the scheme above outlined it is believed beyond question that operation throughout the entire proposed range of heads, and even a greater range if desirable, is entirely practicable.

The resultant curve of turbine efficiency platted from the Holyoke test data of a representative of each

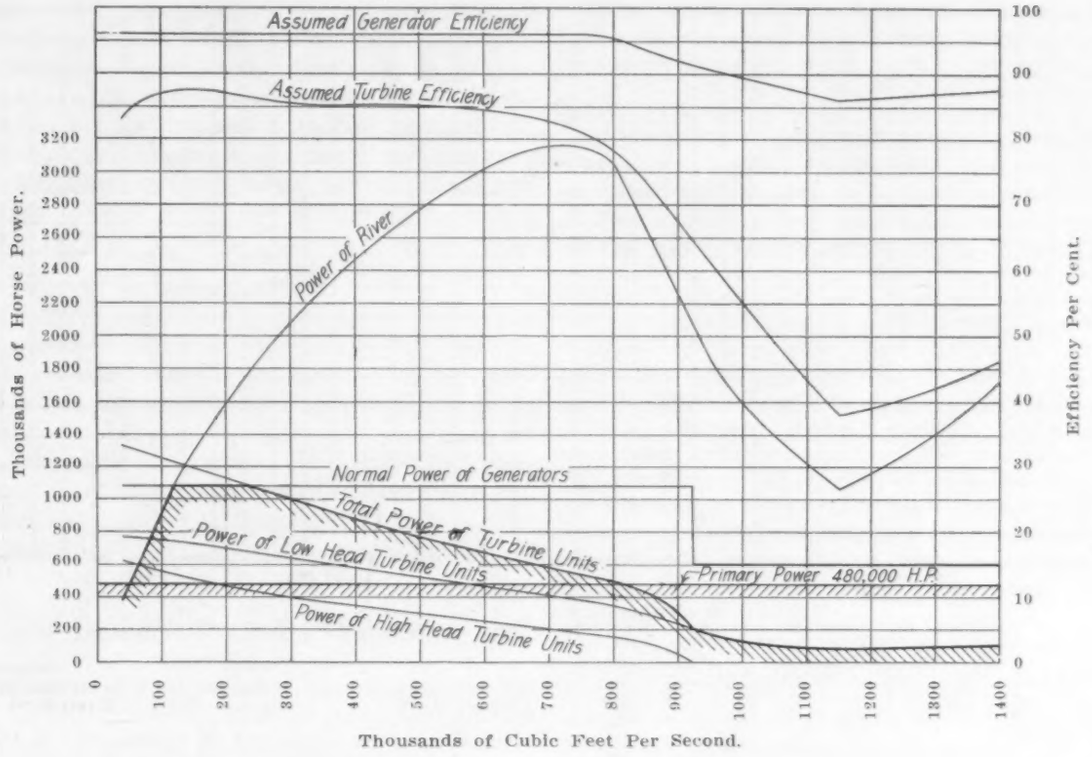

Assumed Generator Efficiency
Assumed Turbine Efficiency
Power of River
Normal Power of Generators
Total Power of Turbine Units
Power of Low Head Turbine Units
Primary Power 480,000 H.P.
Power of High Head Turbine Units
Thousands of Horse Power.
Efficiency Per Cent.
Thousands of Cubic Feet Per Second.

Fig. 23. Machine Efficiencies and Generating Capacities.

type of runners submitted by one of the manufacturers is shown in Fig. 23, after deducting 3 per cent as margin of safety from the results shown by the Holyoke test, and with full consideration of the distribution of load among the two sets of units, the load per unit of each set and corresponding efficiencies. It will be noted that the efficiency would vary from about 84 per cent at a flow of 50,000 second feet upward to 87 per cent at a flow of about 150,000 second feet and down again to 78 per cent at 800,000 second feet corresponding to a net head of 45 ft. For greater discharge the efficiency would fall off rapidly as shown to a minimum value of about 38 per cent as nearly as could be estimated by an extension of the curves of the Holyoke test to this point, which was beyond the range of the test data. These units will be more fully described in the chapter on "Power House and Equipment."

Generator efficiencies. In Fig. 23 it will be seen from the curve of assured generator efficiencies that a value of 96 per cent was assumed nearly throughout the normal range of flow of the river. The efficiency would actually vary, but the variation in any case would be too small to require detailed analysis for present purposes.

Power of the river at low water. In Fig. 23 is shown a curve representing the total power of the river if it were all used for power purposes with the above assumed turbine and generator efficiencies and according to the program of head control shown in Fig. 20.

A flow of 50,000 second feet has been assumed as the minimum for the purposes of this estimate. By reference to the hydrographs and to Fig. 24 it will be seen that the flow has fallen below this amount only

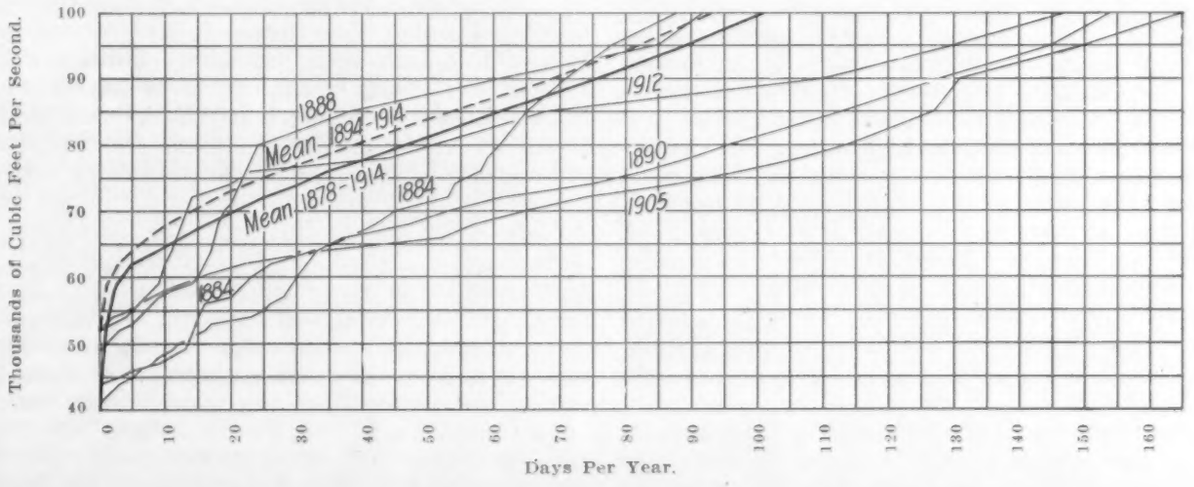


Fig. 24. Duration Curves of Mean and Extreme Annual Low Water Periods.

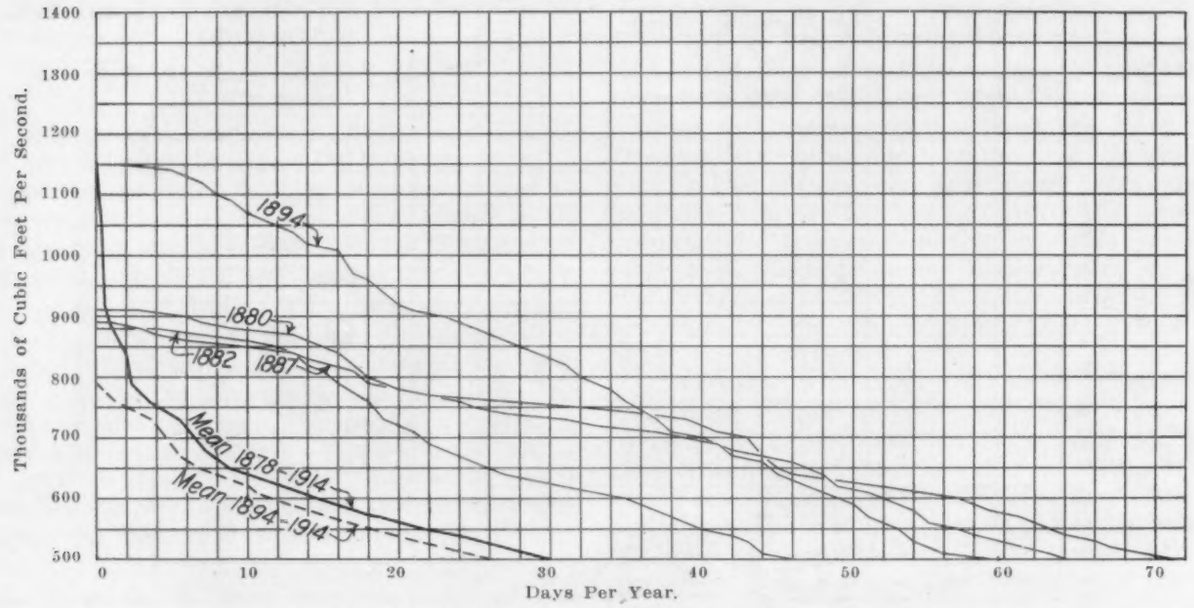


Fig. 25. Duration Curves of Mean and Extreme Annual High Water Periods.

three times in the thirty-six years of available records, the periods of deficiency being: 1884, 12 days; 1888, 1 day; 1890, 13 days.

During the past twenty years or since 1894 the flow has not fallen below 52,000 second feet. The deficiency below 50,000 second feet has had an average annual duration for the entire thirty-six years of ¾ day per year as computed from the above record of deficiencies and as shown by the heavy line in Fig. 24. The average duration, for the period since 1894, is also shown in the same figure by heavy dotted line.

Upon the showing of these curves one would under usual conditions be warranted in basing the capacity of the station upon an assumed minimum use of at least 55,000 second feet. The value of 50,000 second feet is chosen to allow for leakage through the rockfill dam if this type of dam be adopted, also for leakage through the flood control gates, water used for lockage by the Celilo Canal and for a fishway, inaccuracies in stream flow records, etc.

The power which could be delivered to a switchboard with a flow of 50,000 second feet, net head of 105 ft., turbine efficiency of 84 per cent and generator efficiency of 96 per cent, would be a little over 480,000 horsepower, or 360,000 kilowatts, which figure will be adopted as the usual minimum continuous low tension generating capacity of the power site when developed for the maximum practicable head as described.

Maintenance of power at high water. Since power is proportional to the product of water and head, a reduction in the latter which always accompanies high water must be made up by the use of more water, and this in turn requires a larger canal and the expense of more generating units, since the units will not under this condition consume even their former amount of water. The required increase in generating machinery without allowance for reduced efficiency, is indicated by the following table:

Actual Head.	Per cent of Normal Head.	Per cent of Normal Generating Equipment Required.
105	100	100
94.5	90	117
84	80	140
73.5	70	171
63	60	215
52.5	50	283
45	42.8	357
42	40	395
31.5	30	609
25	23.8	860

The minimum head which need be provided for depends upon its frequency and duration. It was shown in Appendix D that a flood of 800,000 second feet which accompanies a net head of 45 ft., and which has been adopted as the flood limit of full station capacity, has a probable frequency, judging from the entire 57 years records, of once in five years, and that this flood has not been reached during the past twenty years. Daily discharge records extend back thirty-six years, and during that time this flood has been exceeded only four times. Duration curves of the flood seasons for those four years are shown in Fig. 25, also the mean curves of the thirty-six years and of the past twenty years. It will be noted that the duration of 800,000 second feet has been as follows:

1880.....18 days	1887.....17 days
1882.....16 days	1894.....32 days
Mean of 36 years	2.3 days
Mean of 20 years	0.0 days

The figures in the above tables indicate clearly the futility of trying to maintain full power for heads below 45 ft., and even the range of heads already adopted may at first be considered excessive. It must be remembered, however, that the minimum head of 45 ft. is fixed by natural conditions and any change of the range of operation would need to be made by a reduction of the maximum head of 105 ft. and consequently of the station capacity. The machine equipment must be chosen for the low head of 45 ft. A given increase in maximum head, causing a proportionate increase in station capacity, would therefore only increase the number of generating units in the same proportion. The cost per horsepower of the generating units would, however, increase somewhat because the units would need to be designed for greater strength to withstand the higher maximum head. The cost of the canal per horsepower would increase slightly, but both of these increases it is believed would be

much more than outweighed by the fact that the dam and controlling works would be unchanged in total cost and therefore reduced in total cost per unit of station output, as they would need to be built to the assumed height for flood control regardless of head utilized. Operation throughout this range has therefore been adopted, based upon the above general reason and for want of time or funds for comparative detailed estimates.

[To be continued.]

The resistivity of soils vary between 1000 and 5000 ohms per centimeter cube. Increasing the pressure tends to slightly increase the conductance, as does likewise increase in moisture and fall in temperature.

The Ferris Bill was passed by the House of Representatives on January 8th, in spite of the opposition of Western Republicans who insisted that its leasing provisions would delay waterpower development. A hard fight is anticipated in the Senate.

SOUTHERN CALIFORNIA EDISON CONDEMNATION HEARING.

The testimony of S. M. Kennedy, general agent for the Southern California Edison Company, before the Railroad Commission of California in its hearing on the condemnation of the company's distribution system in Los Angeles, was concluded December 28th. Mr. Kennedy's evidence was a graphic recital of the building up of the commercial business of Southern California Edison Company, and a projection of its commercial possibilities in the event of severance of Los Angeles business up to the year 1923.

In order to demonstrate that the business of the Southern California Edison Company, outside of Los Angeles, has been developed to a very high degree, Mr. Kennedy presented a statement showing the estimated income per capita in each of the company's districts, and also the total average per capita, namely $8.84, on the company's system, outside of the city of Los Angeles. A statement was also presented showing the income per capita of twenty of the larger companies scattered over the United States, operating under conditions relatively similar to the Southern California Edison Company. Only two of these companies indicated a larger income per capita than Southern California Edison Company's system outside of the city of Los Angeles. These were the Denver Gas & Electric Company with an income per capita of $8.86 and the Edison Electric Illuminating Company of Detroit with an income per capita of $9.74. The average income per capita of Southern California Edison Company is unusually high in spite of the fact that the average rates of the company are considerably lower than in any of the cities referred to on the list presented.

To further illustrate the development of his company's business outside of the city of Los Angeles, Mr. Kennedy presented a statement showing the annual load factors for the year 1914 of twenty large companies located in various parts of the United States. The load factor of the entire system of Southern California Edison Company is 57.86 per cent, and without the city of Los Angeles 50.09 per cent. On the list presented by Mr. Kennedy the highest load factor of companies operating under conditions resembling those of Southern California Edison Company was the Pacific Gas & Electric Company of San Francisco, with a load factor of 60.05 per cent and the Rochester Railway & Light Company with a load factor of 52 per cent.

Mr. Kennedy demonstrated how the business had been developed, and the kind of work which had been done and which is constantly being done to turn every opportunity into an electric use. Car loads and train loads of gas and steam engines have been purchased by the company in the past and replaced by electric motors. Something like 160,000 electrical appliances for household use, using from 4 amperes to 6 amperes, have been sold by the company to its customers during the past eight years; and, in further development of this class of business Mr. Kennedy explained that his company had found it advisable to purchase from its consumers more than 10,000 sad irons and gas irons allowing a small amount on the purchase price of an electric iron in each case. The company had also purchased from its customers many thousands of coffee pots and allowed a small amount for each with the purchase of an electric coffee percolator. These were instances of the methods adopted to put out electric appliances and apparatus where the ordinary methods of sale would not accomplish the purpose. The estimated annual income from these household appliances in daily use is conservatively estimated to be in excess of half a million dollars.

Mr. Kennedy explained in detail the growth of the business in each of the eleven districts outside of Los Angeles during the past eight years, and gave the causes in each case when the growth seemed to be above normal, and when in some years a district showed a decline there was at hand a prompt reason therefor.

After the record of Mr. Kennedy's experience in the past it seemed as if he were qualified to make an estimate of the probable growth of the company in the future. The maximum demand on the company's system for the year ending June 30, 1915, was 55,880 kilowatts, and the maximum demand for the same period, if the Los Angeles business were severed, would be 34,261 kilowatts. It was estimated that the present load factor on the company's business outside of the city of Los Angeles, namely 50.09 per cent, would continue during the coming year, and according to Mr. Kennedy's estimates of kilowatt hour consumption it appeared that by June 30, 1923, the new business, outside of the city of Los Angeles, would have reached a maximum demand of 55,212 kilowatts, or about 668 kilowatts less than it was during the year ending June 30, 1915. However, the volume of business for the year ending June 30, 1915, would not have been regained in 1923, although the peak demand would be regained approximately at that time, the deficiency being accounted for by the difference in load factor. The total estimated increase in kilowatt hour output for the year ending June 30, 1923, was approximately 68,000,000 kilowatt hours more than for the year ending June 30, 1915, in the event of severance of the Los Angeles business from the company's system. Mr. Kennedy's testimony clearly demonstrated that in the event of severance of the company's business in city of Los Angeles from the balance of the system, the conditions of operation of both the severed portion and the remaining portion of the business would be seriously affected. From a present system load factor of approximately 58 per cent, the Los Angeles business would, if severed, immediately drop to 47 per cent and outside of Los Angeles the load factor would be 50 per cent. This retrogression would have a disastrous effect on operation, and expenses would increase all along the line. Mr. Kennedy's estimates for the future growth on the system outside of Los Angeles were based upon the company's ability to operate in the future as it had been doing in the past; namely to be enabled to keep its costs down to the present minimum and thereby to be able to quote such rates as would attract new business as well as hold old business, and, further, be in a position to meet competition from any source. The trend of Mr. Kennedy's asumption was that in the event of severance of that portion of the business now in the city of Los Angeles, the Southern California Edison Company would be allowed full compensation for the injury and damage to the remaining portion of its property through the loss in load factor and diversity factor, as well as the disruption to the organization which would inevitably follow.

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Standardizing Rural Credits

The financial flounderings of the farmer have tended to deter investment in agricultural securities in general and irrigation bonds in particular. The average farmer is encumbered with a heavy load of debt, the aggregate of which is not conducive either to encourage investment or to assist in the rapid development of the land. Some form of relief is necessary.

In the past, irrigation projects have suffered greatly from land speculation, undue taxation and disproportionate promoter's profits. The irrigation district has done much to eliminate these evils, but there still remains the fact that the irrigation district bond does not always find a ready sale.

This sluggishness is largely due to the unnecessary diversity of securities. The forms of irrigation bonds are legion, their differences create misunderstandings and the consequent confusion destroys confidence. There is need for uniformity and standardization in irrigation district bonds.

One way in which this greatly to-be-desired uniformity could be accomplished would be by the enactment of the bill which has been introduced in Congress by Senator W. L. Jones. While providing for federal guarantee of interest on irrigation district bonds, it makes possible the requirement that the irrigation district laws of each state be uniform, so that advantage may be taken of the law's provisions.

The proposed law employs the irrigation district as the unit which shall issue forty-year four per cent bonds, to be guaranteed by the Secretary of the Interior after his department has examined and approved the plans. This scheme can be extended to projects completed under the Reclamation Act and would probably supersede it, as it is now practically inoperative for new developments. The laws of the several states could then be so modified that an irrigation district bond would have the same meaning in all parts of the country and thus become attractive to investors.

Some such action is necessary to make possible the development of a large portion of the semi-arid West. A greater agricultural activity is the backbone of this nation's continued prosperity. The farmer, more than any other class, needs aid and encouragement.

Most of the engineers in the West are heartily in accord with these principles. The public utility men, likewise, realize that their prosperity is dependent upon that of the districts they serve. Some banking concerns, however, are inclined to regard any proposal for government aid in the matter of rural credits as an encroachment on their present prerogatives.

A number of excellent suggestions have been made by the bankers whereby every farmer can obtain credit by simplifying the machinery of the investment market without the necessity of direct loans by the government. They point out the fallacy in attempting to fix interest rates by statute and suggest that the problem

might be cared for by a number of district land banks similar to the federal reserve banks. This proposal has the merit of not making the farmer an object of charity. There is a vast moral difference between helping a farmer help himself and giving him something for nothing. The one developes independence, the other breeds dependence.

It is to be hoped that Congress will not adjourn without providing the needed relief. There is nothing that can add more to the material prosperity of this country than the cultivation of the millions of acres of arable lands which need only a restoration of the investor's confidence so that funds may be available to irrigate them and thus make them productive.

Where Ignorance is Not Bliss

News of a most remarkable decision by the Washington Public Service Commission was published in these columns two weeks ago. Commission decisions may be remarkable for either one of two characteristics—either a broadness and clarity of vision, or otherwise. With all due respect to commission decisions in general, candor compels classification of this particular decision in the latter category.

It seems that the Pacific Power & Light Company has been charging rates of from ten to sixteen cents per kilowatt hour for residence lighting in a number of small towns throughout eastern Washington. These rates are higher than those charged by other companies in Washington and California performing a like service. Among the reasons assigned by the commission for the higher rates is the fact that the power company is selling to large consumers "at or below average cost, and in order to show a fair return the company must make up whatever loss there may be by high rates to other consumers of electrical energy."

The commission fails to add that these rates to large consumers are likewise higher than rates to similar large consumers elsewhere. They seem to overlook the influence of both load factor and diversity factor in the making of a rate. The amount of current used by a consumer is of less consequence in determining the cost of service than is the time at which this current is used. Furthermore the low rates to small towns in the Puget Sound region and in California have been made possible by the fact that there are large cities at the terminals of the transmission lines passing through these small places.

The demand factor, likewise is a feature, whose import is apparently not fully appreciated by the commission when it reduces the charge of $12 a horsepower year of the connected load to $1 per month per horsepower, payable during those months that the power is being used. This is equivalent to cutting the revenue from this class of business almost in half as irrigation is practiced only six or seven months during the year. Meanwhile expensive equipment is being held idly in readiness.

Yet, like many another commission decision, the bark is worse than the bite. The actual reductions ordered by the commission are no greater than would undoubtedly have been voluntarily made by the company in order to encourage the use of electricity in a territory which is destined to a rapid increase in industries and population. We hold no brief for the company in this case, but merely suggest the desirability of a better understanding on the part of the commission of the importance of load, diversity and demand factors in arriving at a proper rate.

Business is Better

On every hand is the belief that business is better and though many can give no definite reason for their belief, the feeling is in the air and is perhaps a precursor of rapid improvement. But an optimism which is unfounded or outside the pale of possible realization may be but hallucination and it is well to analyze closely the belief in business improvement and so prepare for the wave crest of prosperity or to weather continuance of an undesirable depression.

The pessimist will grumble that improvement has been prophesied for the past seven years without fulfilment. Well, that should be a long enough period to justify a change. And whether optimist or pessimist is right, the fact remains that there is room for improvement and the majority, expectant, are ready though perhaps not prepared for it.

Practically all other successes contribute to the success of the electrical industry.

For the past two years crops have been usually good and money which recently sought the long stocking has been again enticed into the open and seems available in greater plenty everywhere for commercial expansion.

Though governmental uncertainty and unwarranted restraint have not been entirely removed from water power and necessary hydroelectric development allowed to proceed untramelled, the greater appreciation and growing demand for improved appliances is everywhere in evidence while the Aladdin cry of "New lamp for old" is adding greatly to the prospects of that desirable prosperity which all anticipate and which will make further construction and additions to plant inevitable.

The belief in improvement finds added support in the existence of a car shortage and in various freight blockades due, it is affirmed, not so much to the movement of munitions and materials of war as to domestic merchandise. Increased industrial activity is an actuality.

War orders, which have been enjoyed largely by the East, are but an unreliable, and at the best, artificial business stimuli and it is the part of wisdom for the West to realize that its prospective wave of prosperity will not be largely or materially influenced from this source but will arise out of a natural and healthy though unprecedented growth. Electrically, the West will maintain its high record of per capita consumption, or, rather, utilization of current.

The belief that business is better and will be better still is well founded. The penalty of progress is obsolescency but the reward is increased business. Opportunity is importunate in her efforts to arouse. Prosperity is upon you but you must stretch forth your hand.

PERSONALS

H. E. Sanderson, Pacific Coast manager Bryant Electric Company, is at Seattle.

J. A. Foster, electrical dealer of San Mateo, spent the last few days at San Francisco.

R. E. Frickey, engineer Northern California Power Company at Redding, has been at San Francisco.

J. A. Hunt, proprietor of the J. A. Hunt Electric Company, Pleasanton, Cal., was a recent visitor at San Francisco.

George Neth, superintendent of the Exide depots of the Edison Storage Battery Company, is at San Francisco.

E. D. Hollenbeck, electrical contractor and dealer of Gilroy, Cal., was a recent business visitor at San Francisco.

J. W. Knibbs, formerly with the Otis Elevator Company at San Francisco, has been transferred to the company's Portland office.

H. B. Kinney, president and general manager of the Calistoga Light & Power Company, was a recent business visitor at San Francisco.

J. H. Lash, chief engineer for the Technical Bureau Svendu of Java, is at San Francisco in the course of a trip of inspection through the United States.

W. A. Kramer, formerly with the Allis-Chalmers Company, and recently in business for himself at Portland, has opened an office in San Francisco.

W. L. Goodwin, vice-president and sales manager of the Pacific States Electric Company, is making a month's business trip to Portland, Seattle and the Northwest.

Chas. E. Bruff of the engineering firm of Bradley, Bruff & Leborthe, has returned to Alaska, after placing some large contracts for electrical apparatus to be installed during the spring.

G. R. Purvis, Pacific Coast manager of the Hurley Machine Company, recently returned to San Francisco in company with Mr. Hurley, having spent the past two months in Southern California.

P. M. Longon, comptroller of the Mount Whitney Power & Electric Company of Visalia, Cal., with **F. G. Hamilton,** superintendent western division of that company, were recent visitors at San Francisco.

H. F. Wolfe, sales manager of the California Electric Supply Company, at San Francisco, who has been confined to his bed for the past week with a serious illness, expects to be out shortly.

E. A. West, efficiency engineer for the Portland Railway, Light & Power Company, is at Denver, Colorado, at the request of **F. W. Hild,** vice-president of the Denver Tramways Company, to advise on an efficiency system for that company.

Max Loewenthal, electric heating expert, who has been doing special work for the California Railroad Commission at Los Angeles, has been made consulting electrical engineer for the Dohrman Commercial Company and their ten retail stores.

J. B. Megson of the Busch-Sulzer Diesel Engine Company of San Francisco, has just left for Texas with the Diesel engine which was installed at the P.-P. I. E., which is to be erected in the plant of the Houston Ice & Brewing Company, Houston, Tex.

Neil C. Hurley, president of the Hurley Machine Company, and **E. N. Hurley,** vice-chairman of the Federal Trade Commission, and family, arrived at Los Angeles recently, where he will leave them for the winter. Mr. Hurley spent a few days this week at San Francisco, and from there he intends to visit Portland and Seattle before returning East.

A. H. Griswold, plant engineer of the Pacific Telephone & Telegraph Company at San Francisco and **L. T. Ferris,** research engineer for the company, addressed the Portland sections of the American Institute of Electrical Engineers and the National Electric Light Association on the subject of inductive interference between power circuits and telephone lines at the January 11th meeting.

J. G. De Remer, at one time chief engineer of the United Light & Power Company, at San Francisco, has resigned as manager of the general engineering department of the American District Steam Company, to take up private practice in general engineering in New York City. He will make a specialty of the promotion and development of district heating in combination with electric central stations.

Harmon F. Fischer has resigned as assistant professor of electrical engineering at the University of California to join the Research Company of New York City as electrical engineer. This company is developing the Cottrell precipitation patents. On his way East he is inspecting the several plants already equipped, including those at Riverside, Cal., Tooele and Garfield, Utah, and a number of plants in Colorado.

OBITUARY.

George A. Wilbur, one of the few remaining pioneers of the early-day electrical development in California, died at San Francisco January 7th, after an illness of over a year. Mr. Wilbur came to California in 1884 to supervise the installation of a street lighting plant built by the Fort Wayne Electric Company for the Stockton Gas Company. After arranging for city lighting plants at San Diego and Alameda he went East in 1885 and was made district manager for the Fort Wayne company at Philadelphia. He was highly successful in this work, selling and establishing many central stations in that district. He remained with the company until it was taken over by the General Electric interests. In 1904 Mr. Wilbur returned to California as the representative of a number of electrical manufacturers. After the fire of 1906 he was with the Standard Electric Works for a time and then established himself as a manufacturers' agent handling Duncan meters, Triumph generators and other lines. He was a man of the highest personal character, a Mason and an active church worker. His life was spent in the service of others and his passing leaves a gap in the ranks of the old timers. He is survived by a wife and daughter, brother and sister.

Loren E. Hunt, chief assistant city engineer of San Francisco, died January 8th at San Francisco, following a brief illness. Mr. Hunt was born in Minnesota in 1870. Three years later his parents moved to Santa Barbara, where he lived as a boy. He was a graduate of the University of California, and during his college days was a famous athlete. Following his graduation he became a lecturer on civil engineering at the university. In 1902 and 1903 he was assistant city engineer, going back to Berkeley then as a lecturer until 1909, when he again became assistant city engineer. In 1911 he was made chief assistant. He leaves a widow and a son.

MEETING NOTICES.

Alameda County Electrical Development League.

In lieu of the regular monthly meeting for December, the Great Western Power Company will banquet the membership on January 17th, with a dinner cooked entirely on an electric range. Covers are being set for those directly connected with the power company in their campaign for "Cooking With Electricity" and will represent many of Oakland's leading "lights" in the electrical industry. W. W. Briggs and others equally prominent will deliver short talks.

San Francisco Electrical Development and Jovian League.

The League's first luncheon of the year was held January 5th at the Palace Hotel with an attendance of 106 members. President E. M. Cutting acted as chairman of the day, telling of the plans for an active administration and announcing the personnel of the several committees. A number of excel-

lent vocal numbers were rendered by the Columbia Park Boys' Club. In accepting the league's contribution of $26.50 to their work, Major Sidney S. Peixotto, their leader, told of the good that is being accomplished in thus educating boys. Dr. J. Wilson Shiels then gave a most interesting talk regarding human types, interspersing his serious characterization with humorous stories. He deplored the lack of idealism in the people and made a strong plea for the development of well-rounded men.

Jovian Electric League of Southern California.

The regular weekly meeting of the league—the first of the new year—was held as usual at Christopher's on January 5th, President Holland in the chair. Mr. Holland called on O. D. Harris of the Pacific Electric Railway Company, chairman of the day, to take charge of the meeting. The chairman introduced a number of New Year resolutions for the benefit of various members, which were heartily applauded. He then introduced Clarence E. Adams, the speaker of the day, who gave a highly interesting and instructive talk on "The Kaiser and His Empire—a Lesson in Efficiency." Mr. Adams, who has traveled extensively throughout Europe for a number of years, stated that in his belief the day of petty competition has practically passed, and that success is principally achieved through earnest and thorough co-operation. He sketched in a few words the commercial rise of the German nation, and pointed out the fact of its being due principally to an intelligent application of efficient methods in manufacture and marketing. He felt that all countries could take a lesson from the German Empire in this respect, and that the careful analysis and study made in that country of manufacturing methods will have its effect on business throughout all countries. He pointed out that the Emperor himself has not confined his attentions to building the military and naval program of the country, but that he personally had been largely responsible for the development of manufacturing industries and foreign commerce.

Entertainment was furnished by F. B. Howe, blackfaced minstrel, who gave a number of excellent dialect stories and songs, which were heartily applauded. Chairman of the day for the meeting of January 12th is H. W. Harrison, Southern California representative of the General Vehicle Company.

Portland Sections A. I. E. E. and N. E. L. A.

The regular bi-weekly luncheon was held in the Commercial Club, January 6th. Thomas McCuster and Frank Branch Riley of the Portland Chamber of Commerce, made talks for letter-writing week, January 17-28, which is a campaign to spread the fame of Oregon broadcast. Mr. B. F. Boynton, claim agent P. R., L. & P. Co., made a talk on "Safety First" movement with special reference to the work done by the Portland Railway, Light & Power Company. He said in part: Harmony must exist through every company before any consistent "Safety First" work can be accomplished. The first attempt to establish harmony in Portland Railway, Light & Power Company was accomplished by a picnic for all the employes. This was such a success that it became an annual affair. Then the company commenced the "Safety First" education by teaching all of the employes "courtesy." After this followed instruction in "prevention" work. When this work was first undertaken the accidents averaged 38 per day, and only one-half the passengers being hauled there are at the present time. To accomplish better results a "Safety Commission" was organized within the company composed of employes. The accidents decreased until there were only eight accidents per day. This continued until the automobile and "jitney" made its appearance, when the accidents double again. Eight years ago "safety first" education was started in the public schools. The results being that Portland has the best record of any city in the United States as regards accidents to school children. The Portland Railway, Light & Power Company has the best record in the United States for surface transportation, as they have carried 750,000,000 passengers in seven years without killing one.

H. P. Coffin, chairman Safety First Commission, Portland, Oregon, read a comprehensive address on the subject and pointed out in detail the work being done in Portland.

Jay Stephens, fire marshal, also made a short talk upon his work of catching and prosecuting arson cases and catching parties turning in "false fire" alarms. He also told of how the school children were being educated along "safety first" lines. Attendance 60.

NEWS OF OREGON PUBLIC SERVICE COMMISSION.

The Western Telephone Company has been given permission by the commission to change its rates for telephone service in its exchange at Woodburn, Oregon.

The commission has denied the application of the cities of Marshfield and North Bend for a modification of the rates of the Coos Bay Water Company and has ordered that a 250,000 gallon reservoir be constructed, but has eliminated the previous requirement for a ten-inch main.

NEWS OF ARIZONA CORPORATION COMMISSION.

All electrical corporations operating in Arizona have been ordered to file with the commission on or before March 1, 1916, their annual statement for 1915. All gas, electric and water companies, likewise, are ordered to file schedules of rates in effect January 1, 1916.

The complaint against the Pacific Gas & Electric Company for not refunding the cost of wiring a real estate tract has been ordered dismissed.

The Pacific Gas & Electric Company has been authorized by the commission to sell 50 six per cent $1000 bonds and 25 six per cent $1000 convertible debentures at a price of not less than 90 and 85 per cent respectively of their par value.

CIVIL SERVICE EXAMINATIONS.

The U. S. Civil Service Commission announces that examinations will be held March 15, 1916, throughout the United States for the following positions:

Aid, Bureau of Standards (men only); Aid, Coast and Geodetic Service (men only); Assistant, Philippine Service (men only); Assistant Examiner, Patent Office; Assistant Inspector of Boilers, Steamboat-Inspection Service; Assistant Inspector of Hulls, Steamboat-Inspection Service; Computer, Coast and Geodetic Survey (men only); Draftsman: Copyist, topographic, Departmental Service; Engineer Department at large; Marine engine and boiler, Navy Department (men only); Ship, Navy Department (men only); Topographic, Departmental Service; Engineer, second class (or assistant), steam, Departmental Service; Forest Assistant, Forest Service (men only); Industrial Teacher, Philippine Service (men only); Junior Engineer, mechanical or electrical, Engineer Department at large; Laboratory Apprentice, Bureau of Standards (men only); Land Law Clerk, Departmental Service; Local Inspector of Boilers, Steamboat-Inspection Service; Local Inspector of Hulls, Steamboat-Inspection Service.

PUBLICATIONS RECEIVED.

Technologic Paper No. 56, U. S. Bureau of Standards, "Protection of Life and Property Against Lighting," by O. S. Peters. Technologic Paper No. 26, "Earth Resistance and its Relation to Electrolysis of Underground Structures, by Burton McCollum and K. H. Logan. Scientific Paper No. 259, "A New Relation Derived from Planck's Law," by Paul D. Foote.

The 1915 edition of the National Electrical Code, Regulations of the National Board of Fire Underwriters for Electric wiring and Apparatus, as recommended by the National Fire Protection Association.

NEWS NOTES

FINANCIAL.

HONOLULU, T. H.—If the plant of the Honolulu Rapid Transit & Land Company, as it stands today, was to be reproduced either in Hawaii or elsewhere, it would cost $2,448,972, according to the estimation of W. A. Cattell, civil engineer and expert on valuations, according to testimony which he has given in Circuit Judge Stuart's court in connection with the trial of the territory's injunction suit against the Rapid Transit. According to Mr. Cattell's testimony, the depreciation of all the units of the company's system, to date, amounts to $447,034. This includes all the items in the plant, regardless of whether they were installed 10 days or 10 years ago. On April 30, 1915, Mr. Cattell had testified the Rapid Transit plant was worth $2,041,938.

RIVERSIDE, CAL.—W. F. Holt of Redlands, Cal., has sold his electric power plants, transmission lines and electric railway in the Imperial and Coachella Valleys to the Southern Sierras Power Company of Riverside for about $1,500,000. The transaction included the transfer of four electric power plants located at Holtville and El Centro, in the Imperial Valley; the main power transmission line running from Banning to El Centro, including distributing systems in the Imperial and Coachella Valleys; the Holtville interurban railway from El Cerrito to Holtville; the Coachella Valley Ice and Electric plant at El Centro, and real estate valued at $200,000. The gas plants at El Centro, Imperial and Brawley, in the Imperial Valley, and real estate valued at $500,000 were retained by Holt.

INCORPORATIONS.

TACOMA, WASH.—The Intermountain Traction & Power Company has been incorporated for $500,000 by I. M. Iles, F. B. Chandler, Alfred B. Iles.

SEATTLE, WASH.—The Electric Heating & Manufacturing Company has been incorporated for $75,000 by P. F. Appel, R. H. Walker and James G. Eddy.

SAN FRANCISCO, CAL.—The Great Western Electrical Chemical Company has been incorporated with a capital stock of $2,500,000, by C. E. Hall, E. Mackennae, W. Forrest, H. A. Cooke, L. A. Reynolds, J. A. Koontz, G. E. Oaks, J. B. Hassett and S. H. Harold.

SANTA ANA, CAL.—The Newport Heights Water Company has been incorporated with a capital of $120,000. The directors are: S. Townsend and A. T. Covert of Long Beach, D. J. Dodge, George Huntington and H. B. Woodrough of Newport Heights.

ILLUMINATION.

FT. SUMNER, NEW MEX.—F. C. Baker is planning to install water works and an electric plant here.

HUNTINGTON, BEACH, CAL.—At the recent election bonds in the sum of $20,000 were voted for the purpose of installing a gas distributing system.

LOS ANGELES, CAL.—The board of supervisors has awarded a contract to the Southern California Edison Company for lighting the Hawthorne lighting district.

WASHTUCNA, WASH.—The power plant in Washtucna, owned by the Washtucna Light & Power Company, was destroyed by fire recently. The loss is estimated at $1000.

SAN BERNARDINO, CAL.—Property owners have signed an agreement to pay for the installation of boulevard lights on Fourth street, between D and E, and on E street between Third and Fifth.

ABERDEEN, WASH.—The request of George H. Tilden for a 50-year franchise to install an electric lighting, heating and power system here probably will be referred to the people at the next general election.

REDDING, CAL.—The city trustees rejected all bids for the erection of the first unit of a municipal lighting system, on the ground that the bids submitted were too high. The board will now go ahead with the work on its own account.

HAMILTON, MONT.—As soon as a flow of 75,000,000 to 100,000,000 cu. ft. of gas can be secured from the Havre gas field the company expects to pipe the product to Helena and Butte, according to W. H. Wheeler and C. A. Rose.

COUPEVILLE, WASH.—The electric lighting plant of Coupeville has been purchased by the Whidby Electric Company at Langley. W. C. Cheney, former owner, stated that the new company will begin immediate improvements.

LOS ANGELES, CAL.—The board of supervisors will receive bids up to January 17th for installing and maintaining an addition to the street lighting system in the Annandale lighting district, in accordance with specifications on file with the board.

WICKENBURG, ARIZ.—P. M. Jewett, who prchased the local electric plant, is preparing to operate on a large scale at Lynch Creek. He is moving part of the equipment from the local plant to that place and expects to install a lighting system there.

SAN FRANCISCO, CAL.—The illumination of Market street was discussed when more than 100 representative San Francisco business men and city officials met at luncheon under the auspices of the Downtown Association with Walter D'Arcy Ryan, the Exposition illumination expert. Ryan's scheme to make San Francisco the best lighted city in the world was approved by Supervisors James E. Power, Edward L. Nolan and Joseph Mulvihill of the lighting committee of the new board of supervisors.

TRANSMISSION. ..

LIVERMORE, CAL.—Local agent E. W. D'Ombrain of the Pacific Gas & Electric Company, announces that power lines will be built several miles out East avenue.

SAN BERNARDINO, CAL.—Improvements are being planned by the Pacific Light & Power Company. A switching tower will be erected at Second and Arrowhead to cost $2000 and the quarter block at Second and Arrowhead avenue will be cleared for the erection of a substation which will cost $50,000.

LOS ANGELES, CAL.—President Betkouski of the city council states that the water board will take immediate action looking to the construction of the municipal system for the distribution of aqueduct electrical power in the Hollywood, Highland Park and East Los Angeles sections. He declares that unless the power corporations submit a fair price, the water board will call upon Chief Engineer Scattergood to present his plans for the municipal distributing system and make call for bids to furnish material and equipment according to his plans.

TELEPHONE AND TELEGRAPH.

SANTA ANA, CAL.—The Pacific Telephone & Telegraph Company is ready to begin the construction of a telephone building at Fifth and Bush streets. The company has completed the installation of new cables at a cost of $30,000.

WALLA WALLA, WASH.—Russel Creek farmers have voted to incorporate a company to be known as the Russell Creek Telephone Association. The company will be owned by the farmers of that section and will control the present Russell Creek telephone line, making improvements and extensions as needed.